

Intel® High Performance Computing Solutions

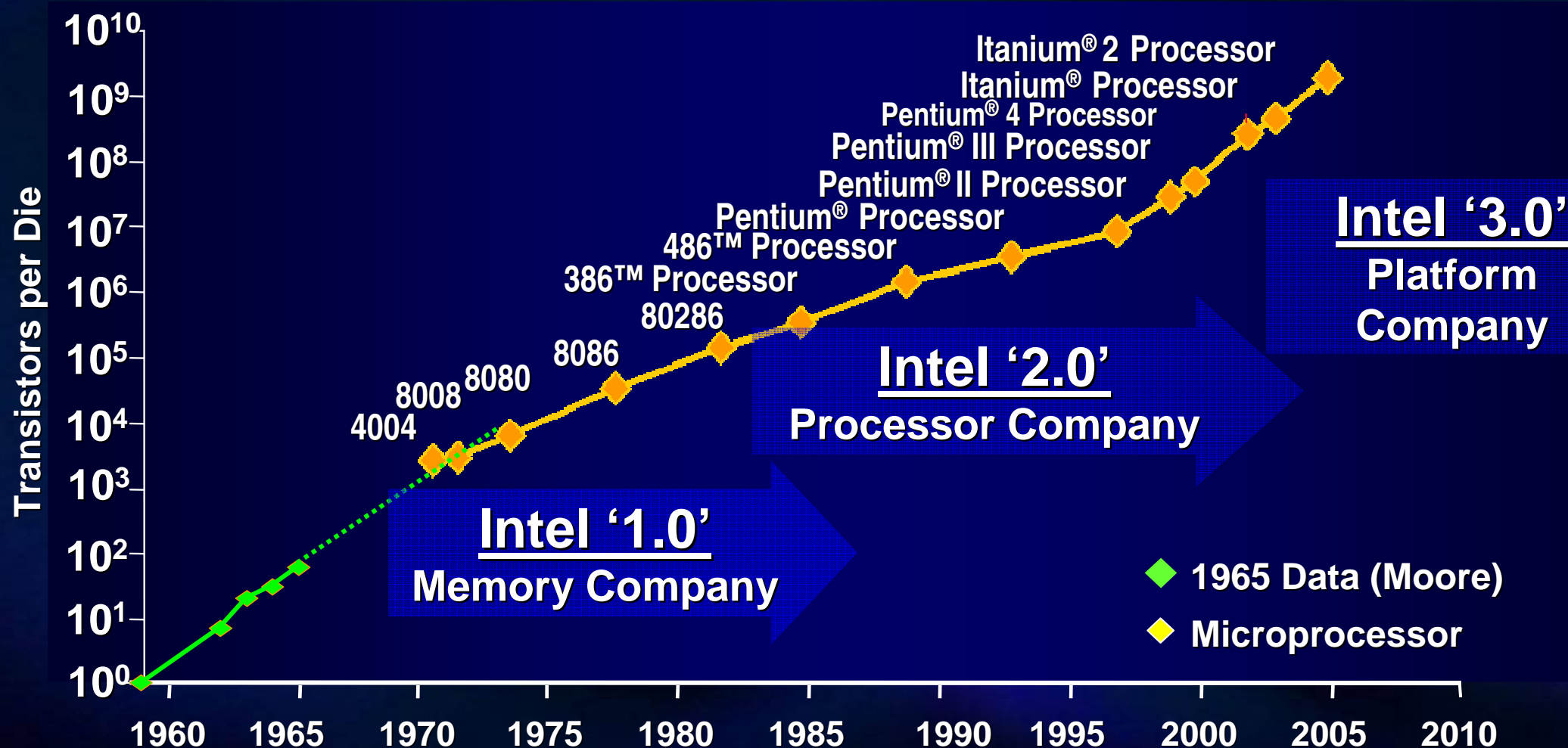
September 27th, 2005
hpcLine Infotag
Paderborn, Germany

Andrey Semin
HPC Technical Programs Manager
Intel Corporation, EMEA



40th Anniversary Of Moore's Law

Evolution of Intel®



Source: Intel



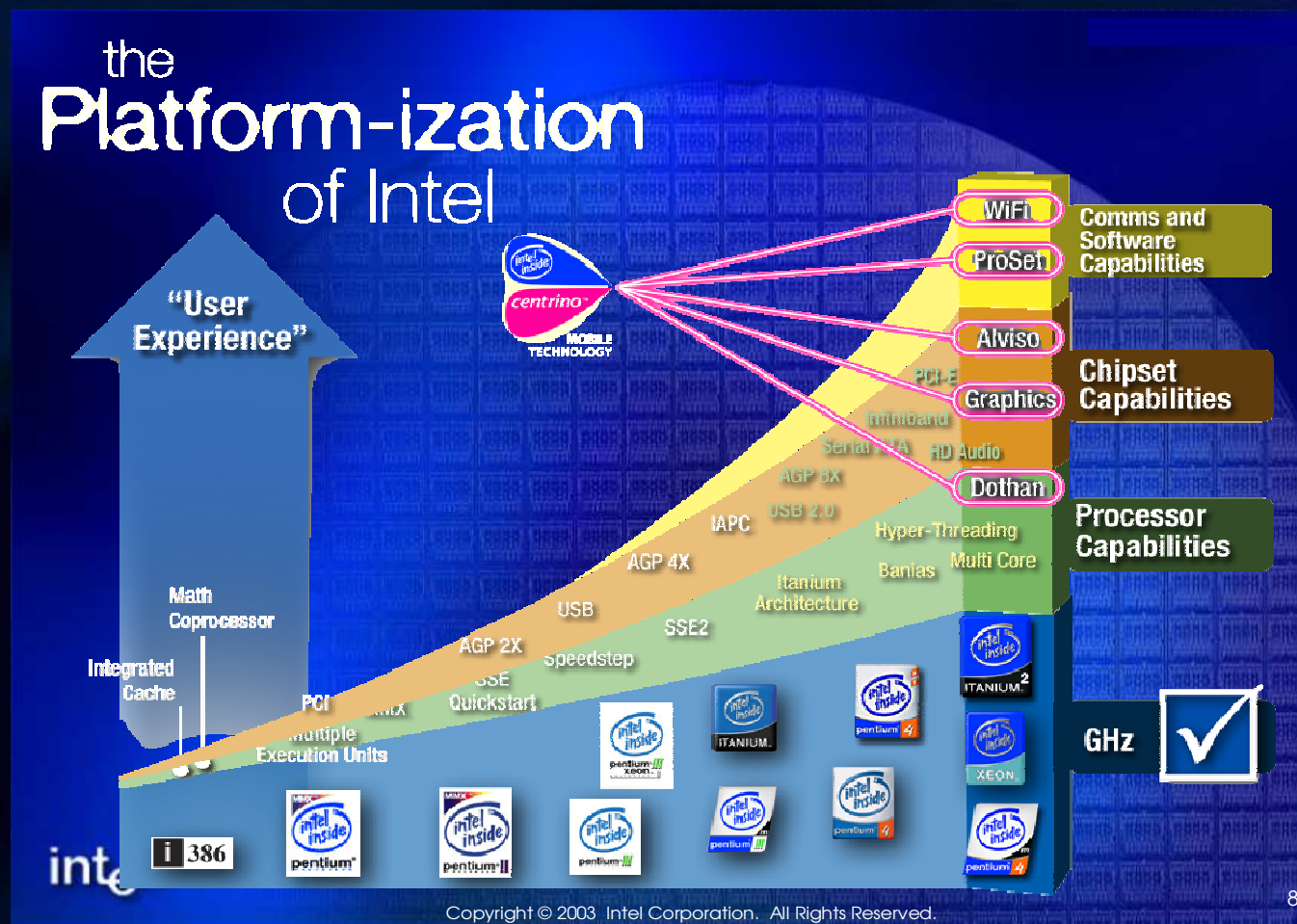
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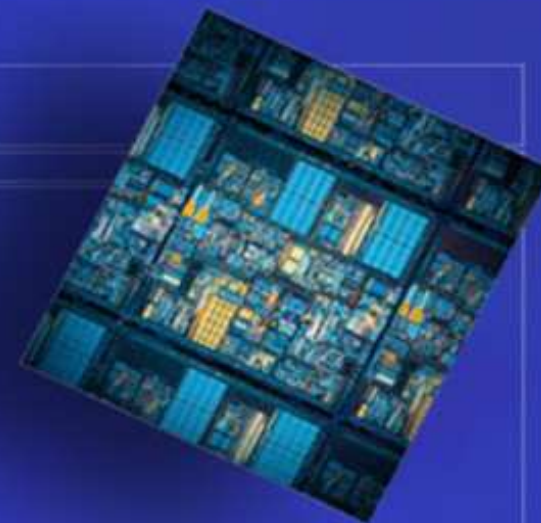
Moore's Law and Manufacturing Capacity

- Moore's Law continues: Transistor count doubles every 24mos
- More transistors = more innovations, capabilities – doing more with the transistor budget
- Seamless integration of end-use features across the computing platform
- Intel Manufacturing: process technology leadership + 300mm wafer capacity = more features, competitive advantage



8

What Define Efficient HPC Solution?



- Theoretical Peak Performance?
- Balanced Platform? (Memory, I/O Bandwidth)
- Power Dissipation per Flops?
- Manageability of large systems?
- ...Software?

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Intel® Server Technology Roadmap



Performance

Balanced Platform

Power Efficiency

Manageability

2004 -2005

Hyper-Threading Tech
PCI Express*
DDR2 Memory

DDR2 Memory
PCI Express*

DBS
Hyper-Threading Tech

IPMI 2.0
LANDesk Mgt Suite

2005-2006

Dual-Core
I/O Acceleration Tech
FB-DIMM Memory

Dual Independent Bus
FB-DIMM Memory

Dual Core
Next Generation μ Arch
Foxton Technology

Active Mgmt Tech
Virtualization Tech

FUTURE

Multi-Core
Enhanced I/O
Enhanced Memory

Next Gen. Platform
Enhanced Memory

Multi-Core
Next Gen. Transistors

Enhanced Manageability
Enhanced Virtualization

plus

plus

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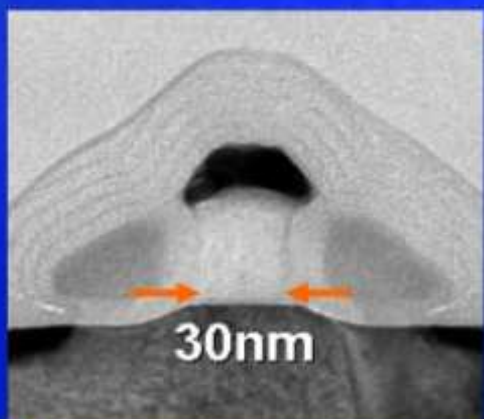
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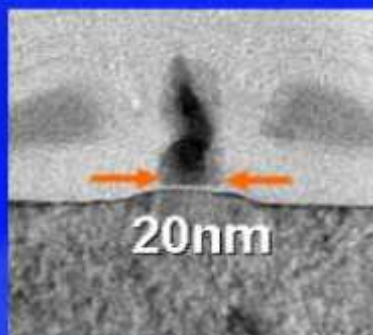
Performance : Smaller and Faster Transistors

Intel's Transistor Research in Deep Nanotechnology Space

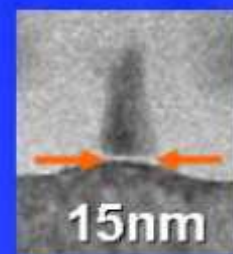
Experimental transistors for future process generations



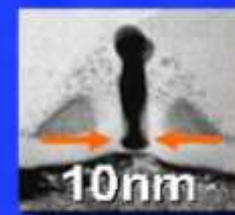
65nm process
2005 production



45nm process
2007 production



32nm process
2009 production

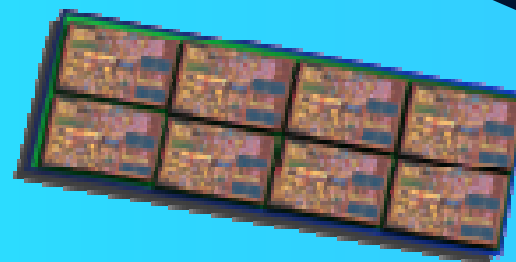
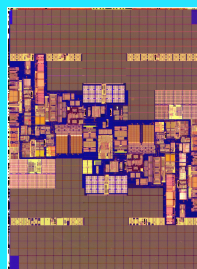
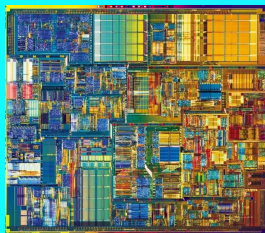


22nm process
2011 production

www.intel.com/research/silicon

Performance : More cores

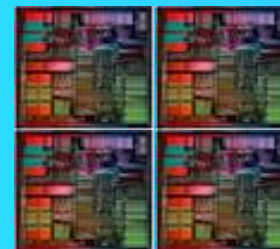
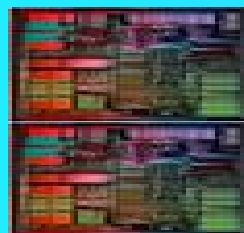
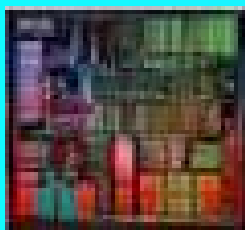
Intel® Server Processors Roadmap



Today
Single-core

2005-2006
Dual-Core

Future
Multi-Core



***Two 64-bit Architectures to Address
Specific Customer Needs***

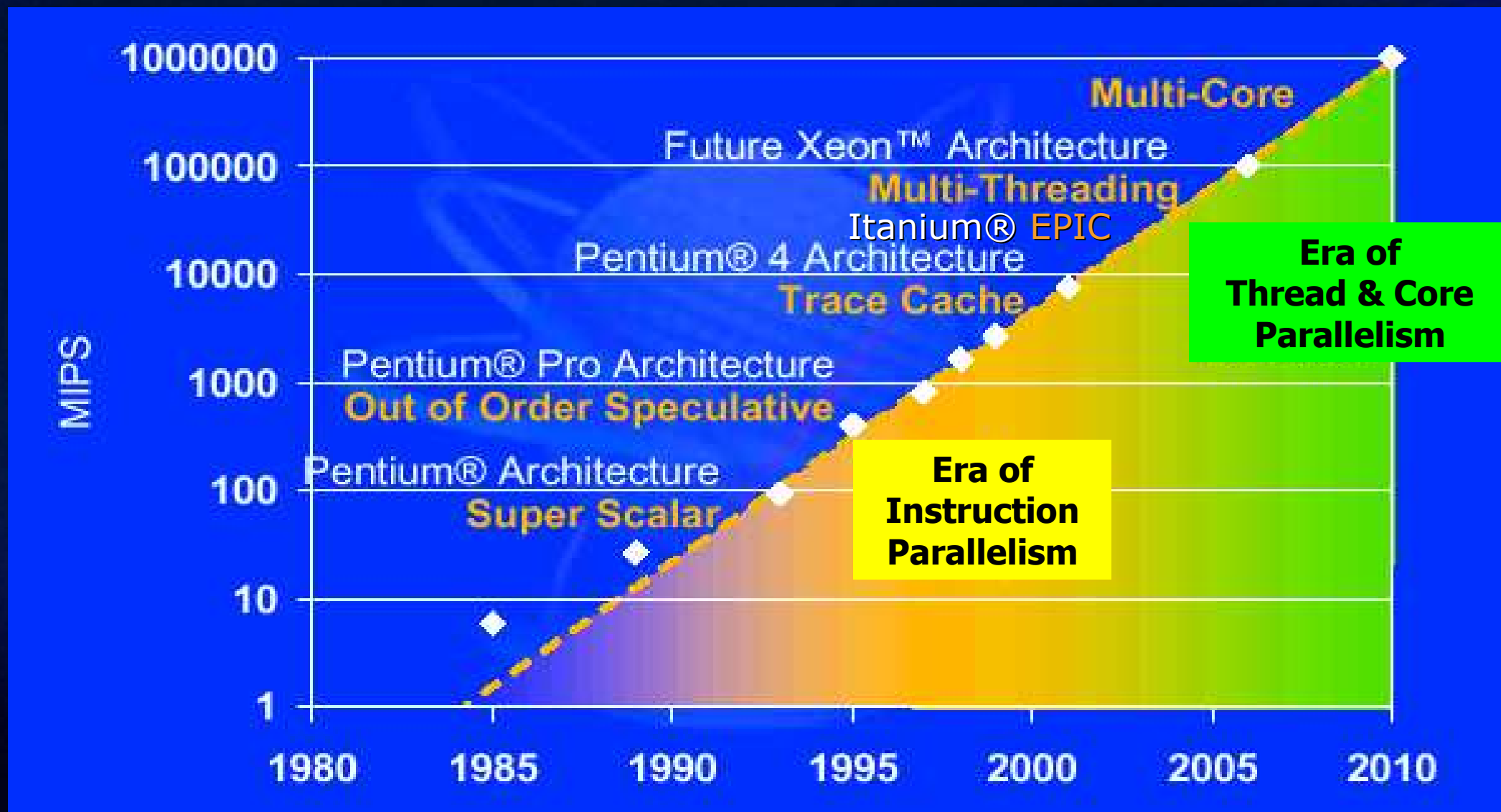
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Performance : Micro-architecture enhancements

Intel® Processor Architecture Trends



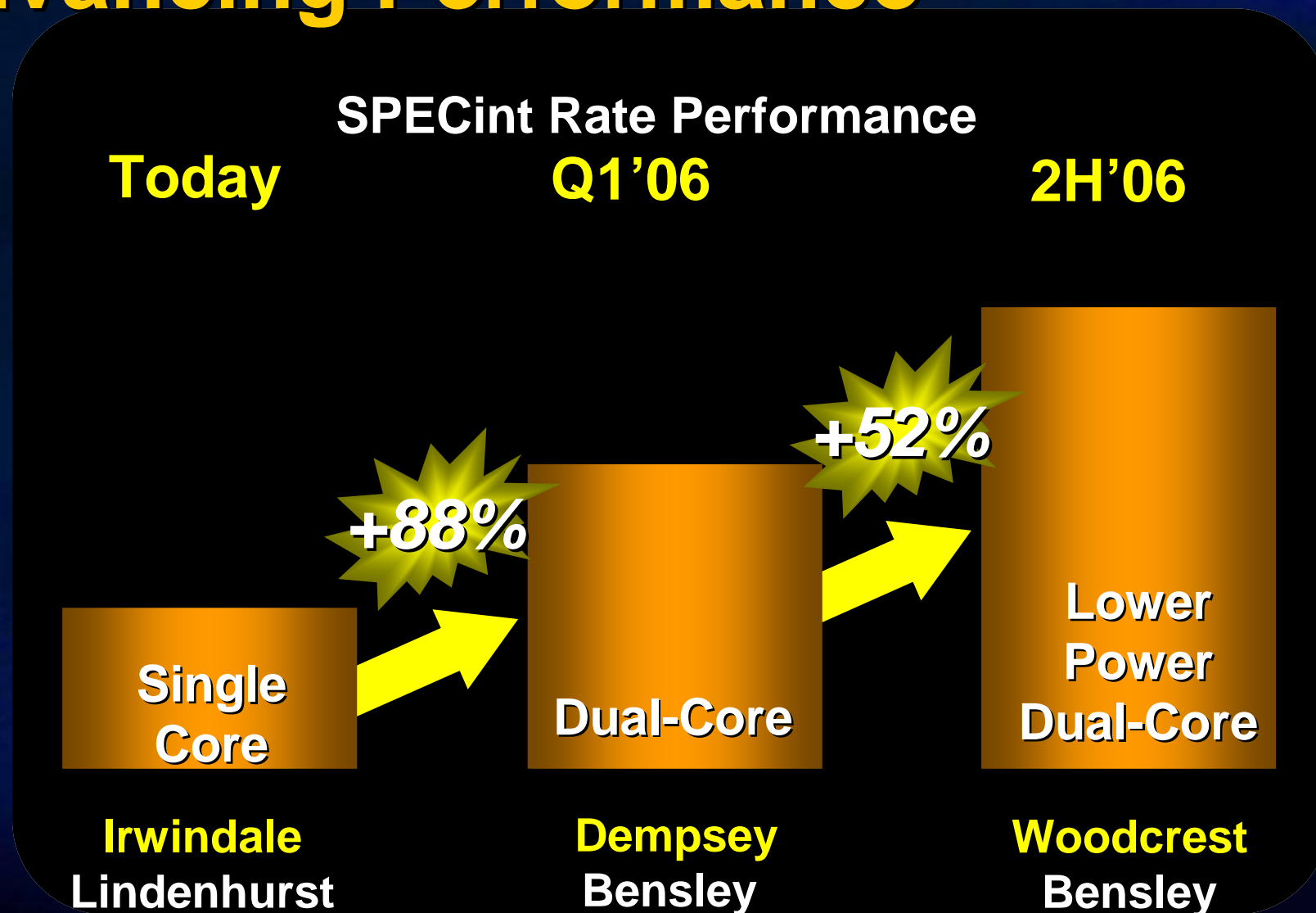
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Advancing Performance



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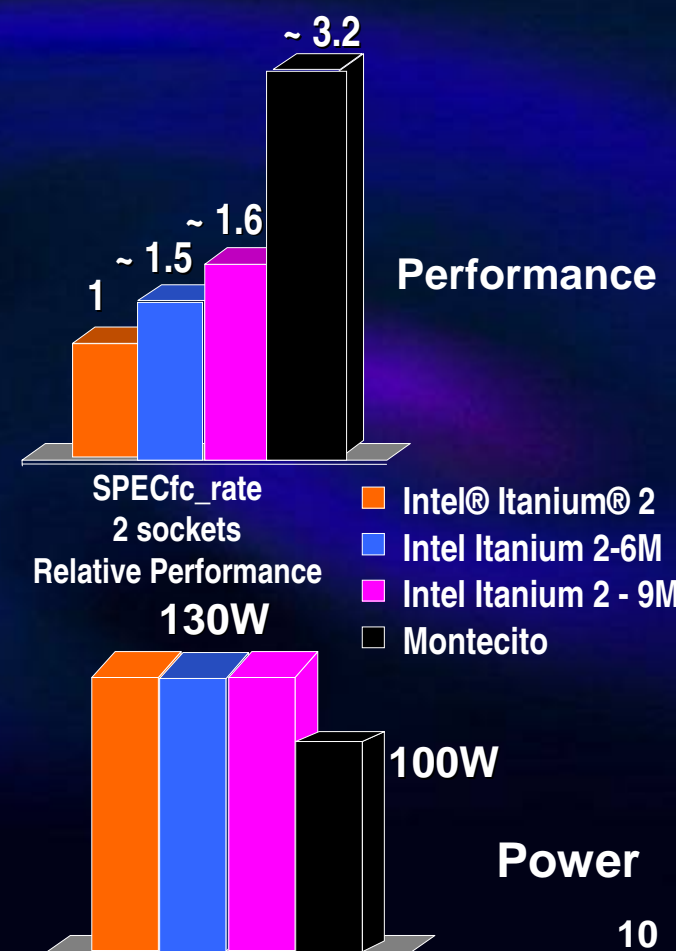
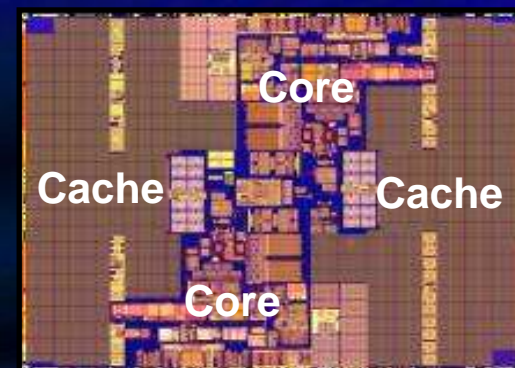
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Next Itanium Processor

- Montecito: Next Itanium® Processor Family product after Madison-9M
 - Dual core, Multi-threading, 24MB cache
 - Platform compatible with Itanium® 2 processor
 - First 1.72 billion transistors processor
 - Significant performance jump with lower power
 - Demonstrated first in 2004
 - OEMs currently testing Montecito platforms
- Montecito also brings new technologies
 - Multi-threading
 - Virtualization Technology
 - Reliability with Pellston, more hardware error correction
 - Demand Based Switching: Server power savings

Montecito



Intel® Server Technology Roadmap



Performance

Balanced Platform

Power Efficiency

Manageability

2004 -2005

Hyper-Threading Tech
PCI Express*
DDR2 Memory

DDR2 Memory
PCI Express*

DBS
Hyper-Threading Tech

IPMI 2.0
LANDesk Mgt Suite

2005-2006

Dual-Core
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FB-DIMM Memory

Dual Independent Bus
FB-DIMM Memory

Dual Core
Next Generation μ Arch
Foxton Technology

Active Mgmt Tech
Virtualization Tech

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Multi-Core
Enhanced I/O
Enhanced Memory

Next Gen. Platform
Enhanced Memory

Multi-Core
Next Gen. Transistors

Enhanced Manageability
Enhanced Virtualization

plus

plus

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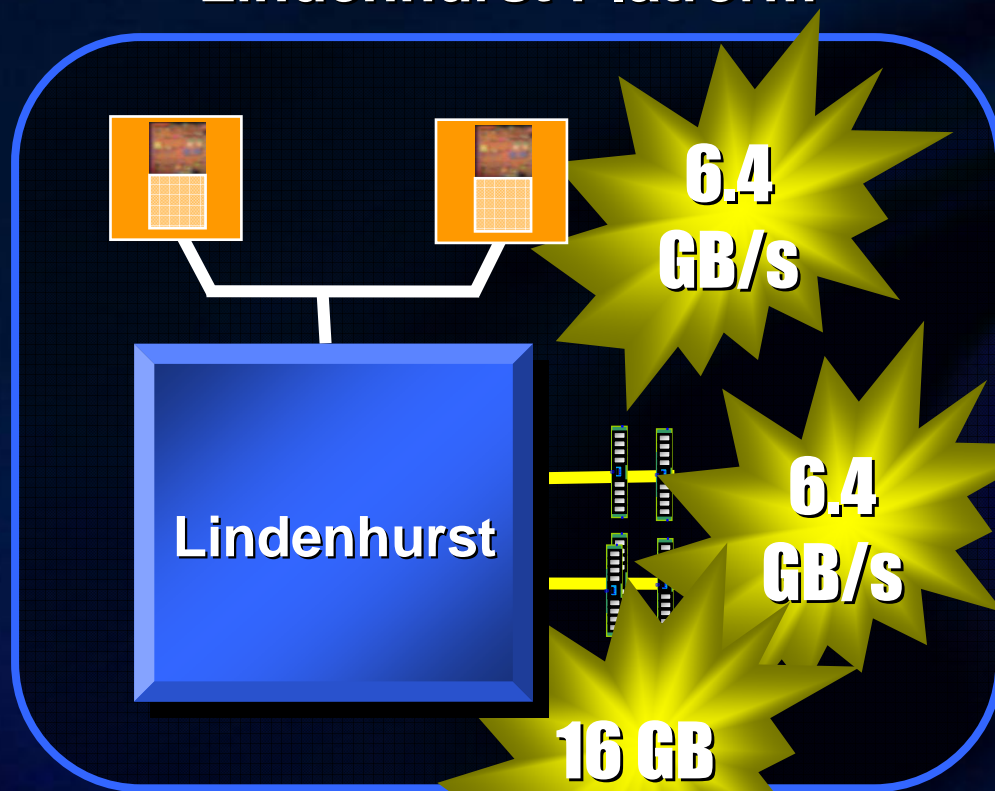


Balanced Platform : Dual-Independent Bus

Next Generation of DP Platforms:

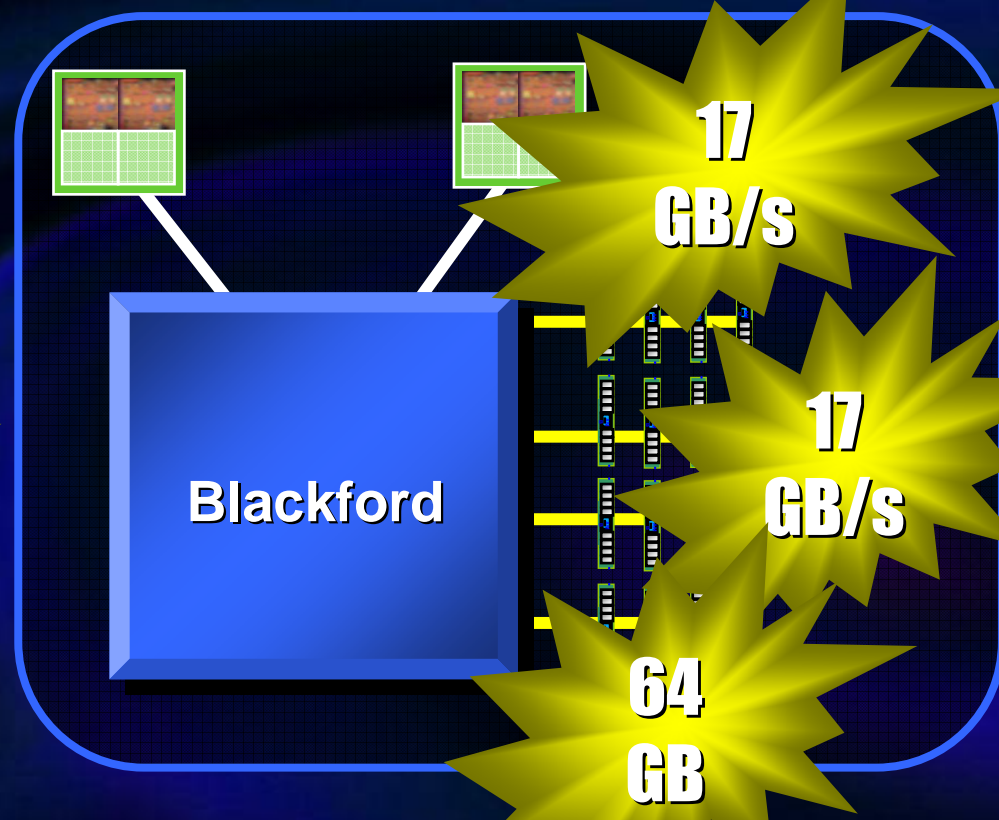
Bensley

Lindenhurst Platform



2004-Today

Bensley Platform



Q1'2006

Delivering Scalable Memory Subsystem

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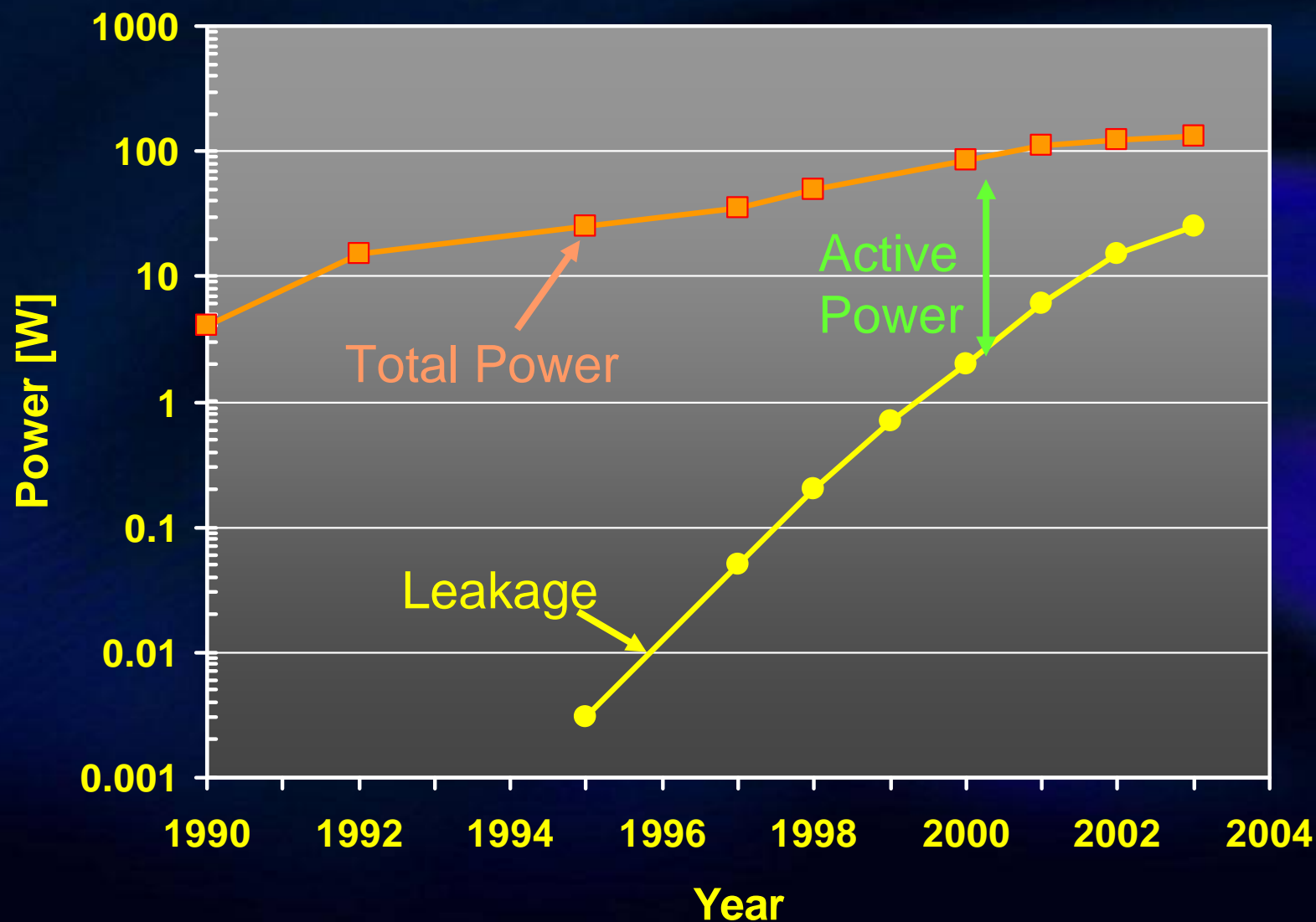
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Active and Leakage Power Trends

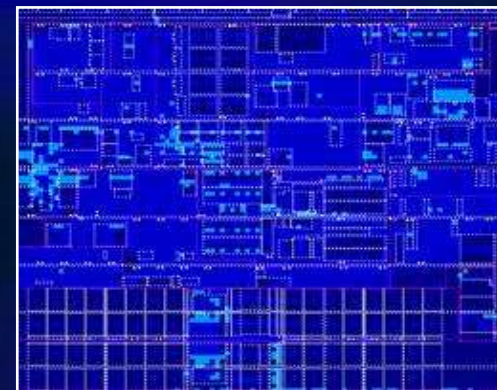




“Beat The Heat”

(IEEE Spectrum, May 2004, Vol. 41, No. 5)

- BETTER HEAT-SINKS
 - Wind tunnels, water/liquid/evaporative cooling
- BETTER MATERIALS
 - Bipolar → CMOS → High-k Dielectrics
- BETTER MICRO-ARCHITECTURES
 - More efficient, power-saving





Power Efficiency: Better Materials

Power Reduction Features

- In addition to on-going improvements such as voltage scaling, new power reduction features are planned for each process generation

	90nm 2004	65nm 2006	45nm 2008	32nm 2010
Strained silicon	✓	✓	✓	✓
Sleep transistors		✓	✓	✓
High-k/ metal gate			✓	✓
Tri-gate transistors				✓

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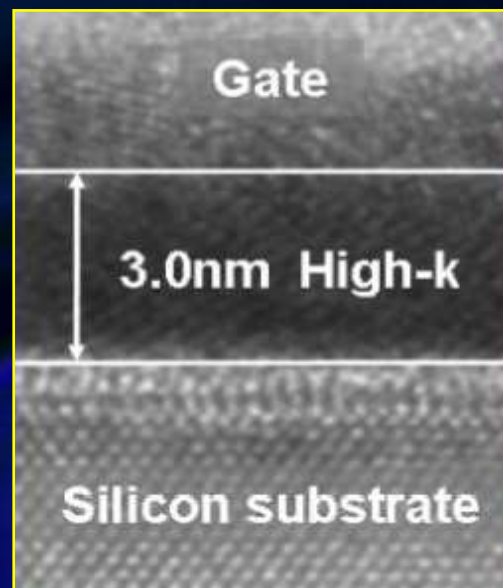
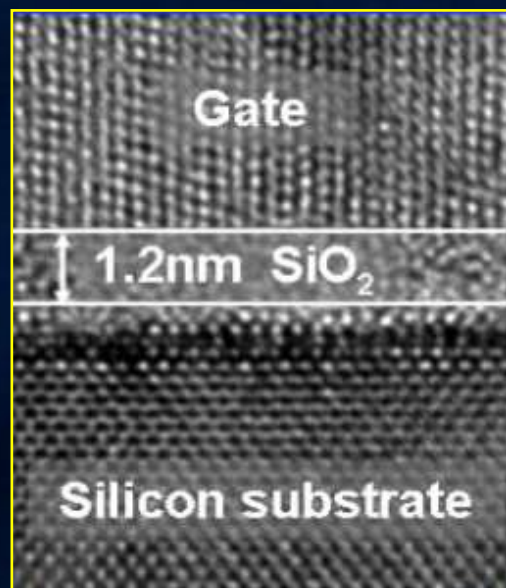
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Power Efficiency: Better Materials

High-k Dielectric Reduces Leakage

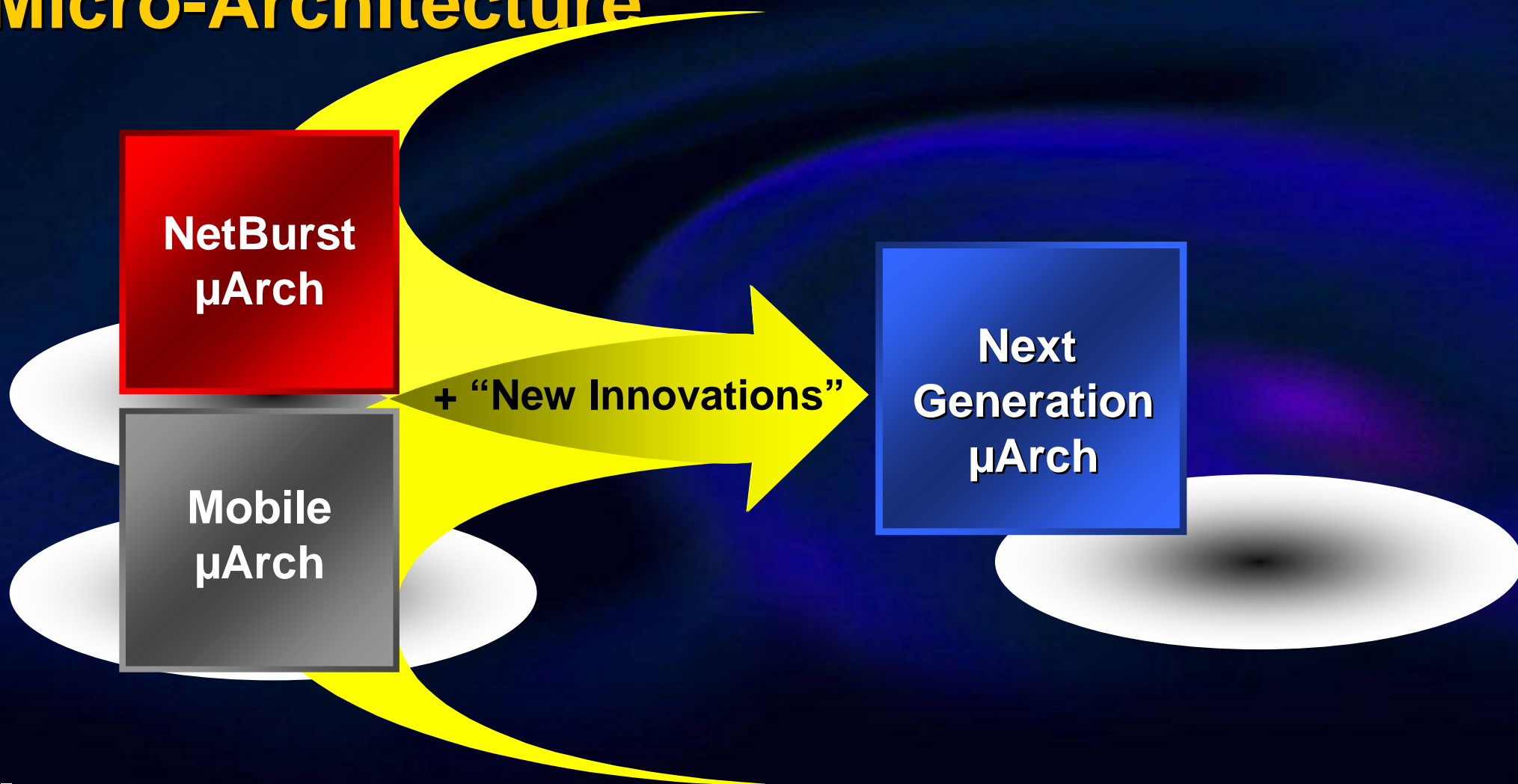


	High-k vs. SiO ₂	Benefit
Gate capacitance	60% greater	Faster transistors
Gate dielectric leakage	>100x reduction	Lower power, cooler

***High-K gate dielectric reduces gate leakage
by up to 100x in the 45nm technology node***

Power Efficiency: Better Micro Architecture

Intel's Next Generation Micro-Architecture

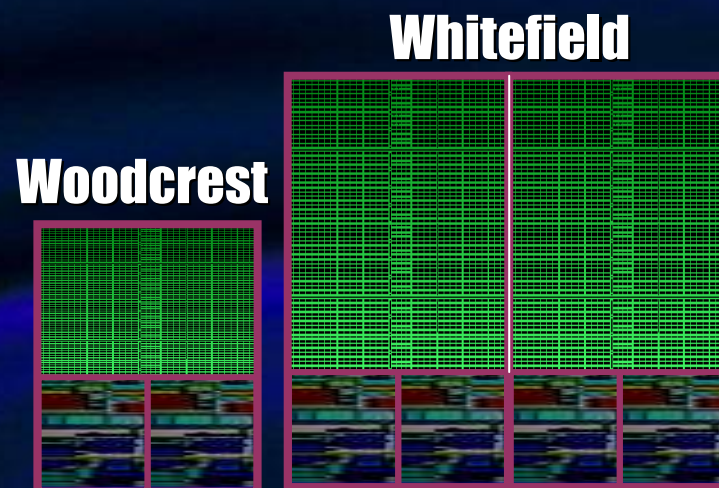


Power Efficiency: Better Micro Architecture

Server Optimized Architecture

- 2 to 4 highly efficient cores
- Large/shared and scalable L2 cache
- 40% reduction in TDP power
- Server *Ts

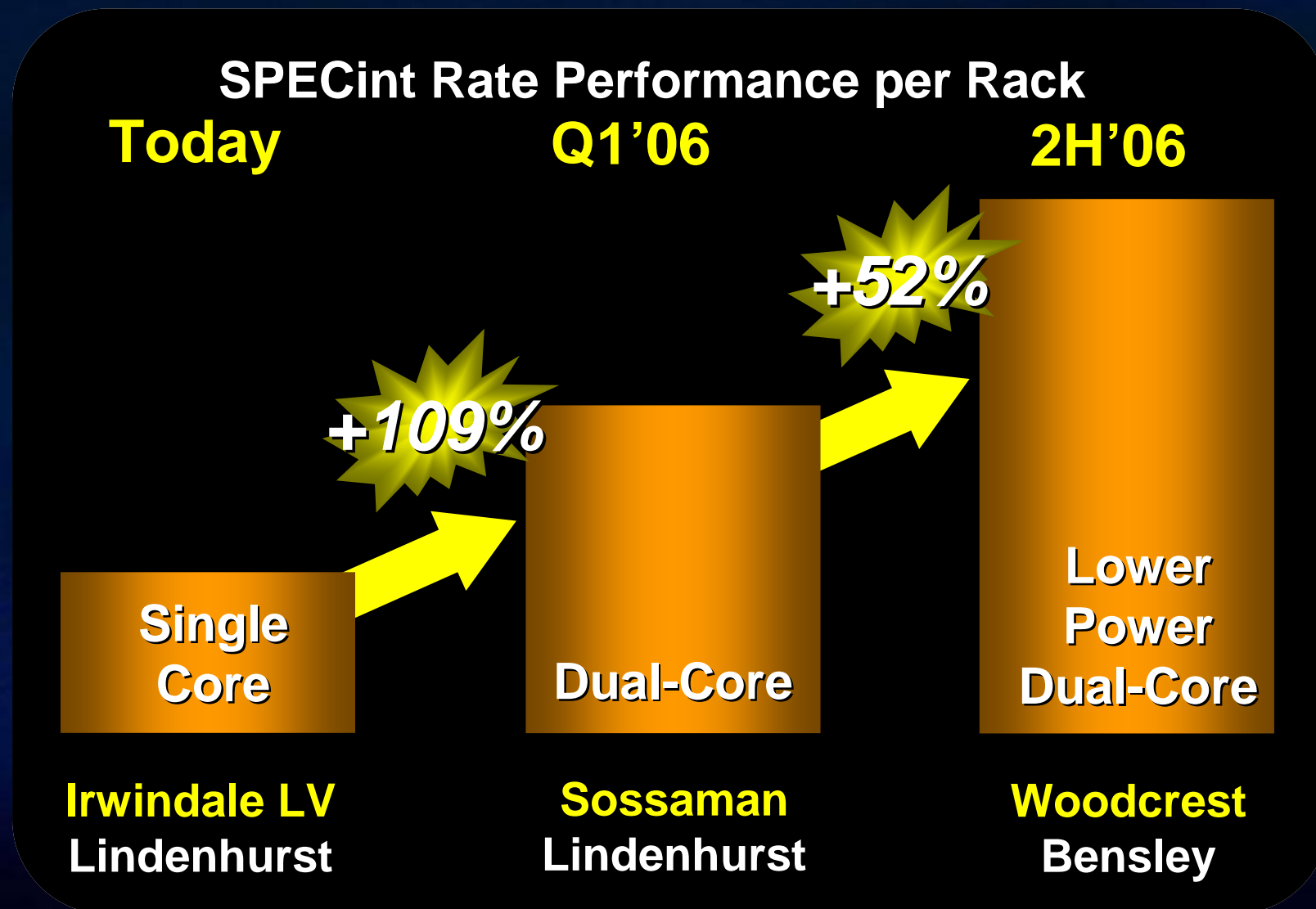
- Greater compute density
- Lower energy consumption
- Greater application responsiveness
- Improved virtualization, manageability, and security



Enabling

Power Efficiency: Better Micro Architecture

Advancing Performance/Watt



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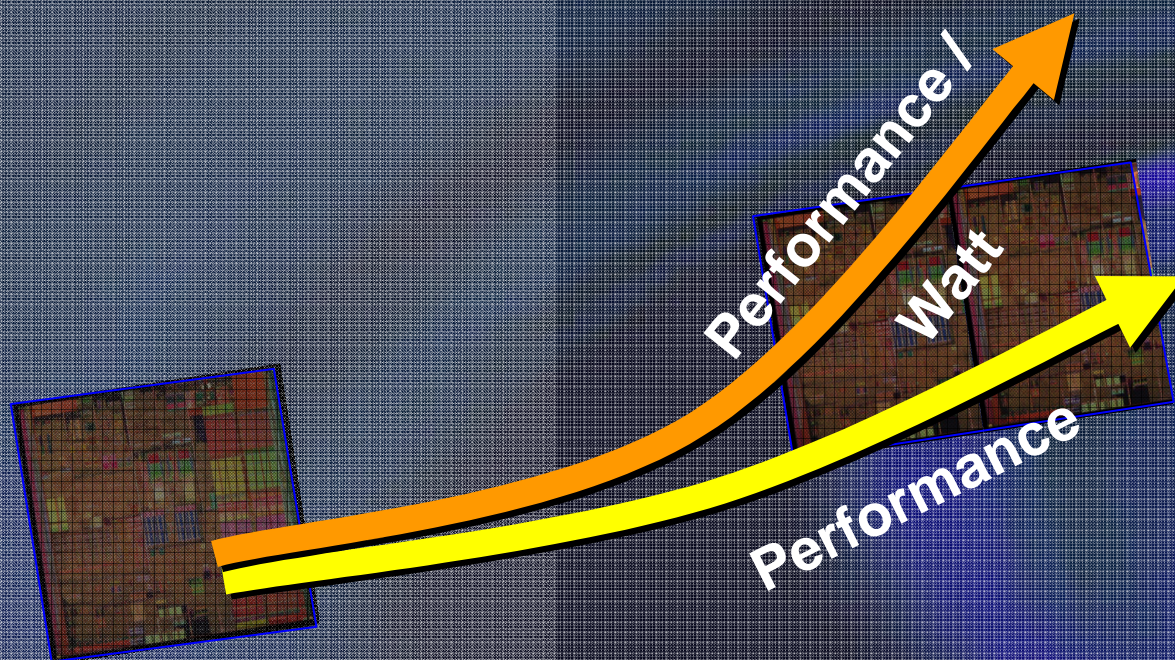
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Power Efficiency

TODAY

2H'06



**Up to 3.5X
PERFORMANCE/
WATT***

**Over 2X
PERFORMANCE***

***Driven By Dual Core, Balanced
Platform Performance and Lower Power Cores***

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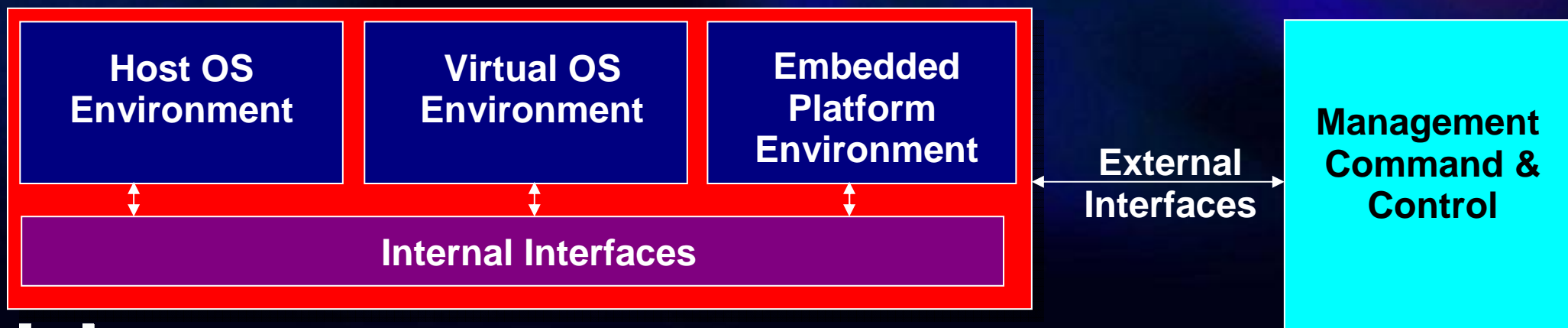
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Manageability Vision

- Consistent manageability across Intel-based platforms
- Management capabilities executing in multiple environments
 - Embedded platform components
 - Virtual partitions
 - The host operating system
- Management capabilities from multiple execution environments cooperating to provide the highest degree of stability, functionality and availability



Improving Efficiency for HPC Users Benefits

Combining Technologies For Greater Benefit



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Intel's Software Tools and Support



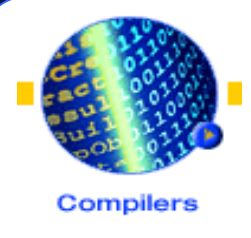
Thread Checker
Thread Profiler

Cluster Tools



Math Kernel Libraries
Performance Primitives

Optimization Labs



Compilers

Solution Services
Developer Services



VTune™ Analyzers

Software College
Early Access Programs



Summary

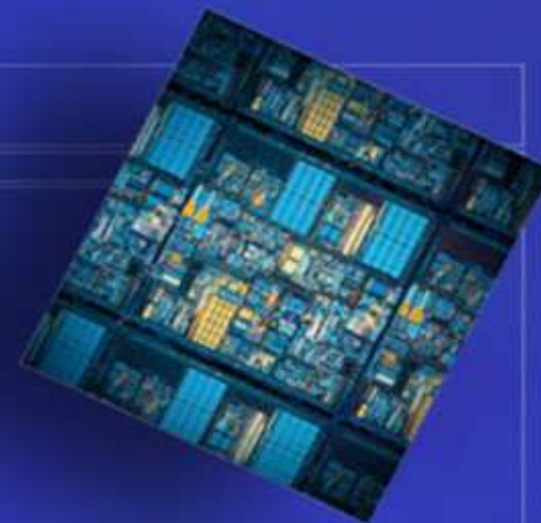
Intel Platforms Deliver

- Processors for Leading Performance
- Balanced Platform Architecture
- Optimized Power Dissipation per Flop/s
- Manageability

*Intel Offers Most Comprehensive
Technology Roadmap and Products
for HPC Solutions*



Backup



Intel in TOP500

Processors								
			Rmax			Processors		
Processors	Count	Percent	Sum (GFlops)	Share	Mean	Sum	Share	Mean
Pentium 4 Xeon	175	35.00 %	398724	23.64 %	2278.42	135348	23.32 %	773
Itanium 2	79	15.80 %	237385	14.07 %	3004.87	50668	8.73 %	641
Xeon EM64T	76	15.20 %	146050	8.66 %	1921.71	35214	6.07 %	463
HP	36	7.20 %	46156	2.74 %	1282.11	22560	3.89 %	626
Opteron	25	5.00 %	106337	6.30 %	4253.48	33568	5.78 %	1342
Power4+	22	4.40 %	97098	5.76 %	4413.55	25194	4.34 %	1145
PowerPC 440	16	3.20 %	364691	21.62 %	22793.19	169984	29.29 %	10624
Power4	15	3.00 %	31092	1.84 %	2072.80	11552	1.99 %	770
PowerPC	9	1.80 %	64377	3.82 %	7153.00	11636	2.01 %	1292
Cray X1	9	1.80 %	25482	1.51 %	2831.33	1944	0.33 %	216
Power5	8	1.60 %	35581	2.11 %	4447.62	6216	1.07 %	777
Power	7	1.40 %	23574	1.40 %	3367.71	26920	4.64 %	3845
Nec	7	1.40 %	53009	3.14 %	7572.71	6552	1.13 %	936
Sparc	5	1.00 %	20099	1.19 %	4019.80	7012	1.21 %	1402
Alpha	5	1.00 %	25653	1.52 %	5130.60	17060	2.94 %	3412
Hitachi SR8000	2	0.40 %	3362	0.20 %	1681.00	1320	0.23 %	660
Pentium 4	2	0.40 %	4276	0.25 %	2138.00	1812	0.31 %	906
MIPS	1	0.20 %	1608	0.10 %	1608.00	6144	1.06 %	6144
Intel	1	0.20 %	2379	0.14 %	2379.00	9632	1.66 %	9632
All	500	100%	1686930	100%		580336	100%	